US009409841B2

(12) **United States Patent**
Davis et al.

(10) **Patent No.: US 9,409,841 B2**
(45) **Date of Patent: Aug. 9, 2016**

(54) **PROCESS AND APPARATUS FOR MAKING PHENOL AND/OR CYCLOHEXANONE**

(71) Applicant: **ExxonMobil Chemical Patents Inc.**, Baytown, TX (US)

(72) Inventors: **Jason D. Davis**, Beaumont, TX (US); **Christopher L. Becker**, Manhattan, KS (US); **Bryan A. Patel**, Jersey City, NJ (US); **John S. Coleman**, Houston, TX (US); **Hari Nair**, Somerville, NJ (US)

(73) Assignee: **ExxonMobil Chemical Patents Inc.**, Baytown, TX (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **14/779,131**

(22) PCT Filed: **Mar. 24, 2014**

(86) PCT No.: **PCT/US2014/031535**
§ 371 (c)(1),
(2) Date: **Sep. 22, 2015**

(87) PCT Pub. No.: **WO2014/165339**
PCT Pub. Date: **Oct. 9, 2014**

(65) **Prior Publication Data**

US 2016/0046550 A1 Feb. 18, 2016

Related U.S. Application Data

(60) Provisional application No. 61/807,407, filed on Apr. 2, 2013.

(30) **Foreign Application Priority Data**

Jun. 25, 2013 (EP) 1373544

(51) **Int. Cl.**

C07C 45/53	(2006.01)
C07C 37/08	(2006.01)
C07C 2/74	(2006.01)
B01J 19/00	(2006.01)
C07C 407/00	(2006.01)
B01J 19/24	(2006.01)

(52) **U.S. Cl.**
CPC ***C07C 37/08*** (2013.01); ***B01J 19/245*** (2013.01); ***C07C 45/53*** (2013.01); ***C07C 407/00*** (2013.01); *B01J 2219/00103* (2013.01); *B01J 2219/24* (2013.01); *C07C 2101/14* (2013.01)

(58) **Field of Classification Search**
CPC C07C 45/53; C07C 37/08; C07C 2/74; B01J 2219/24; B01J 2219/0013
USPC 568/342, 798; 585/467; 422/187, 649
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,303,825	B1	10/2001	Gerlich et al.
7,312,365	B2	12/2007	Black

FOREIGN PATENT DOCUMENTS

EP	0 492 807	7/1992
WO	2009/128984	10/2009
WO	2009/131769	10/2009
WO	2011/100013	8/2011
WO	2012/036822	3/2012
WO	2013/165656	11/2013
WO	2013/165659	11/2013

OTHER PUBLICATIONS

Middleton et al., "Loop Reactors", Ullmann's Encyclopedia of Industrial Chemistry, vol. 21, (2010), pp. 377-382.

Primary Examiner — Sikarl Witherspoon
(74) *Attorney, Agent, or Firm* — Stephen A. Baehl

(57) **ABSTRACT**

A process for producing phenol and/or cyclohexanone by cleaving cyclohexylbenzene hydroperoxide in a loop cleavage reactor comprising multiple reaction zones connected in series. In desirable embodiments, fresh cyclohexylbenzene hydroperoxide feed(s) are supplied to reaction zones the final reaction zone, and fresh acid catalyst is supplied only to the final reaction zone. In desirable embodiments, a portion of the effluent exiting the final reaction zone is recycled to the first reaction zone. Each reaction zone is equipped with a heat exchanger downstream of the feed port to extract heat generated from the cleavage reaction.

25 Claims, 1 Drawing Sheet